

The present invention relates to a fiber which includes a thermoplastic polymer and particles of a ferroelectric material dispersed therein. The thermoplastic polymer may be, for example, a polyolefin, such as polypropylene or polyethylene, and the ferroelectric material may be barium titanate. The ferroelectric material may be present at a level of from about 0.01 to about 50 percent by weight (from about 0.001 to about 13 percent by volume), and will have a longest particle dimension in a range of from about 10 nanometers to about 10 micrometers. The fiber may be exposed to an electric field. A plurality of the fibers may be employed to form a knitted or woven fabric or a nonwoven web. Also provided is a method of preparing fibers containing particles of a ferroelectric material. The method includes destructuring the ferroelectric material in the presence of a liquid and a surfactant to give destructured particles; the liquid is a solvent for the surfactant and the surfactant is adapted to stabilize the destructured particles against agglomeration. A blend of the stabilized, destructured ferroelectric material particles and a thermoplastic polymer then is formed and extruded to form fibers. The extruded fibers may be collected on a moving foraminous support to form a nonwoven web and, if desired, may be exposed to an electric field. The fiber of the present invention, especially when in the form of a nonwoven web, is especially suited as a filtration medium. For example, the nonwoven web may be adapted to remove particulate matter from a gaseous stream.

In the May 29, 2001 Office Action, the Examiner noted that all trademarks should be capitalized and accompanied by generic terminology. It is believed that the amendments to the specification above address the Examiner's concern and it is believed no further action on that point is required.

Response to Rejections under 35 U.S.C. § 103

By way of the Office Action mailed May 29, 2001, the Examiner rejected Claims 50 and 55-66 under 35 U.S.C. §103(a), as being unpatentable over U.S. Patent No. 6,001,299 to Kawabe et al in view of Japanese Patent Abstract JP 63288216A of Oshida for reasons of record. The Examiner contends Kawabe teaches an electret article which in its final shape is a face mask and comprises a fibrous porous article such as a nonwoven fabric, wherein the nonwoven fabric can be meltblown or spunbonded thermoplastic material with ferroelectric materials, such as barium titanate, incorporated therein. The Examiner contends that while Kawabe is silent as to the amount of barium titanate incorporated therein, Oshida teaches thermoplastic fibers having ferroelectric material incorporated therein in the amount set forth by the Applicants. The Examiner

further concludes that it would have been obvious to one skilled in the art to include the ferroelectric material of Kawabe in an amount as known in the art with the reasonable expectation of obtaining the efficacious properties associated therewith. The Examiner also suggests the fiber diameters of the present invention are inherent based on the disclosure of Kawabe, and as such, Claims 50 and 55-66 of the present invention would have been obvious to one skilled in the art.

The Applicants respectfully disagree with the Examiner's statements for a number of reasons. First, the Applicants acknowledge while a patentee has the right to be his own lexicographer, that is "a term used in the claims may be given a special meaning", however, "no term may be given a meaning repugnant to the usual meaning of the term." MPEP §608.01(o). See also MPEP §608.01(g). That is while a patentee may define a word used in the claims of a patent, the patentee may not define the word such that the definition is contrary to the word's traditional meaning. More specifically, the patentee may not define a word to mean something which it is not. That is exactly, what has occurred in Kawabe. Kawabe's unconventional definition of an "electret article" found in column 5, lines 14-53, defines the term to mean two types of "electrets". The first type of electret included in Kawabe's definition is those electrets with charges trapped mainly on the surface of the article being treated. The second type of "electret" included in Kawabe's definition are those "electrets" with micropolarization distributed throughout the volume of the treated article. Those skilled in the art conventionally define an electret to include only the first class identified by Kawabe. The second class of materials Kawabe that defines as "electrets" is conventionally referred to as "ferroelectrics", and those skilled in the art recognize that conventional ferroelectrics are not electrets. Thus, not only is Kawabe's definition incorrect, but it also leads to confusion of the invention unless examined in great detail. Because of the inaccurate definition provided by Kawabe, close examination of the teachings of Kawabe must be further scrutinized to insure that his erroneous definition does not lead one to accept as true teachings which go against the fundamentals of science.

Such an examination of the Kawabe patent reveals that while Kawabe suggests that the two classes of "electrets" defined are interchangeable, Kawabe in fact treats the classes separately and differently. In fact the teachings of Kawabe reveal that the teachings with respect to one class are not applicable to the other class as the Examiner suggests. Specifically, in column 16, line 66-column 17, line 7, Kawabe identifies very different applications for the two classes. That is fibrous applications, such as a filter or

a mask, are only identified as falling within the first class, while each of the applications identified as being within the second class are all monolithic (nonfibrous, nonporous) or thin film ceramic devices, such as a sonic wave generating device or a sonic wave detecting device, or a generator.

While the Examiner has suggested that there is motivation for applications of ferroelectric/electret composites, the Applicants contend that such motivation is in fact absent when Kawabe is read in view of the above remarks, as it is clear to one skilled in the art that Kawabe is silent with regard to any potential ferroelectric/electret composite applications. Given the distinctions Kawabe has identified between the two types of "electrets" as well as the grossly different applications Kawabe suggests for the two classes (column 16, line 66 – column 17, line 12), it is the Applicants' contention that it would not be obvious to one skilled in the art to use the "electret" defined by Kawabe to treat composite materials in a face mask or other filter application.

The Applicants contend that the Examiner has misconstrued the Kawabe patent as a result of the unconventional definition suggested by Kawabe for the term "electret article". Accordingly, the Applicants respectfully request the Examiner to reconsider the Kawabe reference in view of the above remarks and then to withdraw the rejection relying thereon.

Second, there are numerous other inaccuracies in Kawabe which the Applicants believe the Examiner has relied on in making the rejections. For instance, in column 5, lines 54-56, Kawabe suggests that any dielectric can be treated to obtain an electret article. One skilled in the art would recognize this is not an accurate or reliable statement as evidenced by the teachings of G. M. Sessler which are included in the material attached as Exhibit A. G.M. Sessler expressly states that "to be useful for electret studies these substances have to show either suitable polar properties or extremely low conductivity due to a large number of trapping centers. ... It appears that most dielectrics with polar properties have an undesirably high conductivity." Therefore, Kawabe's suggestion is incorrect and unreliable. Another example of the inaccuracies in Kawabe is found in column 6, lines 43-46 where Kawabe suggests a ferroelectric generally results in a surface charged electret article when treated with an electric field. It is known to one skilled in the art that a ferroelectric generally produces an electric polarization in its volume, i.e. a "volume effect". Kawabe makes these bold statements yet offers no support for them. In sum, the patent cited against the Applicants contains many unsupported statements which violate the fundamentals of science. As a result, it

is the Applicants' contention that one skilled in the art would not have looked to Kawabe for any teachings or motivation because the incorrect theories and statements contained therein would have suggested to one skilled in the art that any teachings or conclusions contained therein are also false or incorrect and generally unreliable.

Next, while Kawabe does make one reference to a fibrous porous article made of "ferroelectric material" (column 6, lines 43-46), the Examiner should note that it is made in connection with the indication that when treated with an electric field a surface-charged electret article is obtained. This indication of a surface-charged electret article not only appears to be unsupported (as discussed above), but is in contradiction to that which the present invention suggests. Accordingly, in this regard, Kawabe again teaches away from the present invention, as Kawabe does not disclose or indicate any ability to produce a volume effect, whereas the composite of the present invention has both surface charges and volume polarization's. Page 4 lines 12-15 and pages 8 lines 19-28 Therefore, as the teachings of Kawabe are either scientifically incorrect and therefore unreliable or teach away from the present invention, it is the Applicants' contention that Kawabe is improperly relied on by the Examiner and should be reconsidered and the rejections made in reliance thereon should be withdrawn.

Fourth, in column 14, line 64 - column 15, line 10, Kawabe teaches away from the process used in the present invention. Specifically, Kawabe states "[I]t is noted that the embodiment wherein DC corona discharge elements are used as the first and second ion generating means is not included in the present invention. It is because, as mentioned above, a high voltage must be applied between electrodes in charging treatment using a DC corona discharge element, a higher voltage may cause spark discharge or dielectric breakdown, and thus a dielectric article to be treated may be damaged. Further when a piezoelectric article is produced, the article to be treated is polarized with the electric field formed by the surface charges on the article to be treated. It is difficult to apply the charges necessary to form the electric field enough to polarize the article by the charging treatment using a DC corona discharge element." (Emphasis added.) Thus, one skilled in the art would recognize that Kawabe discusses the difficulties and probable futility of the process that is practiced in the present invention. No difficulties have, in fact, resulted from the present invention. Simply, Kawabe suggests what has been done with the present invention is not readily practical. Thus Kawabe not only fails to provide the teaching, motivation or suggestion the Examiner suggests, but expressly teaches away from the present invention. This

teaching away should be enough for the Examiner to recognize that the teachings and motivations which the Examiner suggests may only arise if Kawabe is misconstrued or inaccurately applied. Accordingly, the Applicants respectfully request the Examiner to reconsider the rejections based on Kawabe and then withdraw the rejections.

Fifth, as discussed in the Applicants' Amendment to the Examiner's first Office Action, Kawabe teaches composites of inorganic piezoelectric ceramics with organic rubbers and thermoplastics like polyvinylidene fluoride and polyacetals; however, the reference does not teach BaTiO₃ and polyolefin (e.g. polypropylene) composite material. The two thermoplastics taught by Kawabe are each inherently different from polyolefins. Polyvinylidene fluoride (PVDF) is itself a ferroelectric polymer, unlike polyolefins. Polyacetals are aliphatic polyethers, and unlike polyolefins, such condensation polymers are not useful for forming electrets; there are no known references in Chemical Abstracts to the use of polyacetals as electrets. Accordingly, as there is no suggestion or teaching to the contrary found in Kawabe or either of the Japanese Patent Abstracts cited by the Examiner, one skilled in the art would not have looked to Kawabe for a teaching related to the present invention.

Finally, the Applicants also believe the Examiner's reliance on the cited Japanese Patent Abstracts of Oshida is improper. JP 63288216A discloses an antistatic polyester fiber obtained by dispersing 1-10 parts by weight of a non-compatible thermoplastic polymer with a polyester containing 10-80 wt% electroconductive particles in 100 parts by weight of a polyester fiber consisting of a polyester containing 0.1-1 wt% dielectric particles. As is clearly stated, the combination of these particles acts as an anti-static agent. This Japanese Abstract does not teach an electret material, i.e. a material having a sustained electrostatic charge. Removing the electroconductive particle from the invention disclosed in the '216 abstract, as the Examiner seems to have suggested, would give rise to a material which is no longer an anti-static agent and therefore would destroy the patentee's original intent and be against all of the teachings therein. Furthermore, because the teachings of the '216 abstract is counter-instructive to that suggested by the Examiner, there appears to be no motivation for the Examiner's suggestion that one skilled in the art would have removed the electroconductive particle in '216 reference to achieve the invention of the present application. That is, one skilled in the art would not seek to form an electret and impart a permanent electrostatic charge to an anti-static fiber (which is specifically designed not to retain residual electrostatic charges). Moreover, since the fibers of the Japanese Abstract comprise anti-static fibers

that contain a considerable amount of electroconductive particles it is believed uncertain as to whether it would be possible to form an electret from such materials. If the Examiner still finds the Applicants' remarks regarding Oshida non-persuasive, the Applicants respectfully request the Examiner to point out the motivation to one skilled in the art to extract one element from an otherwise non-applicable reference which teaches away from the concepts claimed in the present invention. Further, Applicants would also request the Examiner to suggest the motivation for the proposed extraction of the element of Oshida, when the Oshida disclosure further indicates that a third element is required to achieve the results desired therein. Applicants contend the Examiner has failed to provide the required showing of motivation that the ferroelectric materials of Oshida would work in the same fashion if incorporated into Kawabe, especially in light of Kawabe's unconventional definitions and disclosures which go against several fundamentals of science.

In sum it is the Applicants' contention that the Examiner's rejection of the Claims 50 and 55-66 under 35 U.S.C. §103 over Kawabe in view of the cited Japanese Abstract is improper and should be withdrawn.

Lastly, the Examiner has objected to Claims 9 and 12-16 as being unpatentable over Kawabe in view of Oshida, as applied to claims 50 and 55-66, and further in view of PCT Publication No. WO 96/13319 of Pike (hereinafter "Pike"). The Examiner suggests that in addition to the elements discussed above Kawabe and Oshida also teach the multicomponent fibers required by Claim 9. The Examiner further contends that Pike teaches a nonwoven filter media comprising multicomponent fibers wherein the filter media is electrostatically treated to form electret filter media. The conclusion drawn by the Examiner is that the combined teachings of the three references would have rendered the face mask of Claims 9 and 12-16 obvious to one skilled in the art.

The Applicants respectfully submit that the claims to which the Examiner refers in her objection are dependant on claims which are allowable in their current form and once the claims upon which Claims 9 and 12-16 depend are allowed, the remaining claims which depend thereon are also in condition for allowance. Accordingly, in light of the arguments set forth above, the Applicants do not believe any action is required with respect to Claims 9 and 12-16 at this time.

Applicants have carefully reviewed the art cited against the present application. None of the cited references, either alone or in combination, disclose a composite construction which has the same or similar distinctive combination of features as set forth

and claimed by the present application and it is this combination of elements which is clearly and patentably distinguishable over the cited art. All claims are believed to be patentably distinguishable over the cited references and in allowable condition. Applicants respectfully request that the rejections of the claims under 35 USC §103 be reconsidered and withdrawn in light of the preceding remarks.

For the foregoing reasons, the application and claims are believed to be in condition for allowance and such action is respectfully requested. However, should any questions arise with regard to this matter the Examiner is encouraged to contact the undersigned at (770)-587-7183. Please charge any prosecutorial fees which are due to Kimberly-Clark Worldwide, Inc. deposit account number 11-0875.

Respectfully submitted,

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CERTIFICATE OF MAILING

I, William W. Letson, hereby certify that on August 27, 2001 this document is being deposited with the United States Postal Service as first-class mail, postage prepaid, in an envelope addressed to: Assistant Commissioner for Patents, Washington, D.C. 20231.

By: 

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Version with markings to show changes

In the Specification:

The paragraph on page 19, beginning with the words "Dispersions were prepared using ..." has been amended as follows:

Dispersions were prepared using two grades of barium titanate (BaTiO_3) supplied by Tam Ceramics, Inc. (Niagara Falls, New York) under the product names TICON[®] 5016 and TICON[®] HPB. Each dispersion was prepared by ball milling the barium titanate with 2-propanol and a stabilizing surfactant. The surfactant was an ethoxylated tallow amine (RHODAMEEN [Rhomadeen] [®] PN-430, Rhone-Poulenc, Cranberry, New Jersey). In a typical batch, approximately 1 kg of barium titanate was vigorously stirred with 2.6 L of 2-propanol and 4-5 mL of the surfactant. The resulting slurry was poured into a 6.2-L Roalox ceramic mill jar (U. S. Stoneware, East Palestine, Ohio) which had been charged with 12 lbs (about 5.4 kg) of [Borundum] BORUNDUM[®] (87 percent alumina) grinding media (U. S. Stoneware). The jar was rolled at 70 rpm for a period of 48 hours on a U. S. Stoneware Unitized Jar Mill, Model 764AVM.

The paragraph on page 20, beginning with the words "The two wax dispersions ..." has been amended as follows:

The two wax dispersions were separately dry blended with Himont Profax[®] PF-015 polypropylene (Montell Polymers, Wilmington, Delaware). The mixture was melt blended using a single screw compounding extruder. The compositions of the two blends are given in Table 2.

The paragraph on page 21, beginning with the words "Nonwoven fabrics were manufactured ..." has been amended as follows:

Nonwoven fabrics were manufactured on a 100-inch (about 2.5-meter) meltblown line essentially as described in U.S. Patent No. 3,849,241 to Buntin et al., which is incorporated herein by reference. The 100-inch wide web was slit into five 20-inch (about 51-cm) sections. Of these, the outer 20 inches (about 51 cm) on either side of the web were discarded. The remaining three slits represent cross deckle positions from 20 inches (about 51 cm) through 80 inches (about 203 cm). Meltblowing conditions were the same for all materials. The line speed was varied to alter the basis weight. Basis weights of 0.5 ounces per square yard or osy (about 17 grams per square meter or gsm), 0.6 osy (about 20 gsm), 0.75 osy (about 25 gsm), and 1.0 osy (about 34 gsm)

were spun from the [Profax] PROFAX[®] PF-015 polypropylene alone (the control, coded PP-A) and from each formulation containing barium titanate (see Table 2). All basis weights of meltblown webs were electret treated on-line under identical conditions. The electret treatment was carried out in accordance with the teachings of U.S. Patent No. 5,401,446, described earlier.

The paragraph on page 26, beginning with "Barium titanate was obtained from ..." has been amended as follows:

Barium titanate was obtained from the Transelco Division of Ferro Corporation (Dresden, New York, Product Code 219-9). In this example, didodecyldimethylammonium bromide (DDAB) was the stabilizing surfactant. Typically, 200 g of barium titanate was added to 1 L of 2-propanol and vigorously stirred. Approximately 0.8 g of DDAB was added to the mixture. The slurry was stirred and sonicated (Fisher Scientific Sonifier, Fischer Scientific Company, Philadelphia, Pennsylvania) for approximately 5 minutes. The resulting slurry was poured into a 2-L Roalox ceramic mill jar which was charged with 4.5 lbs (about 2 kg) of [Borundum] BORUNDUM[®] grinding media (see Example 1). The mill jar was then rolled at 70 rpm for a period of 48 hours on a U.S. Stoneware Unitized Jar Mill, Model 764AVM.

The paragraph on pages 28 and 29, beginning with the words "Meltblown nonwoven fabrics ..." has been amended as follows:

Meltblown nonwoven fabrics were prepared on a research meltblowing line essentially as described in U.S. Patent No. 3,849,241 to Buntin et al., identified earlier. Meltblown fabrics were made from the [Profax] PROFAX[®] PF-015 polypropylene alone (PP-A) as a control and the polypropylene/stabilized barium titanate formulations containing 1.0 percent by weight and 0.1 percent by weight barium titanate (PF-C and PF-E, respectively). The formulation containing 0.5 percent by weight barium titanate (PF-D) was not melt spun. In each case, webs having basis weights ranging from 0.5 osy (about 17 gsm) to 2.0 osy (about 67 gsm) were prepared. The melt-spinning conditions used for the control and barium titanate formulations were identical.

The paragraph on page 35, beginning with the words "The mixing tank was filled ..." has been amended as follows:

The mixing tank was filled with 190 lb. (86.4 kg) of technical grade 1-butanol. Then, 7.2 lb (3.27 kg) of RHODAMEEN [Rhodameen] PN430 (Rhone-Poulenc) was added with vigorous stirring. The barium titanate was added in 55-lb (about 25-kg) portions until a total of 770 lb (about 350 kg) had been added to the mixing tank. The slurry was pumped to the high speed pin/attriter mill and recycled to the mixing tank for approximately 30 min. The resultant 1-butanol dispersion was uniform in composition and contained 80 weight-percent barium titanate.

The paragraph on page 36, beginning with the words "In this example, ..." has been amended as follows:

In this example, 969.20 lb. (440.55 kg) of 1-butanol/barium titanate/[Rhodameen] RHODAMEEN[®] PN-430 dispersion was combined with 190.8 lb. (86.73 kg) of A-C 16 PE wax. The molten wax and 1-butanol dispersion were blended continuously until no alcohol vapor was detected over the mixture. At this point, the BaTiO₃/[Rhodameen] RHODAMEEN[®] PN-430/A-C 16 PE wax dispersion was poured into a tray to cool to room temperature. The solidified wax composite was further cooled to dry ice temperature and ground to a coarse powder for dry blending with polypropylene.

The paragraph on page 36, beginning with the words "The BaTiO₃/Rhomadeen[®] ..." has been amended as follows:

The BaTiO₃/[Rhodameen] RHODAMEEN[®] PN-430/A-C 16 PE wax composite, 832 lb (about 378 kg) was dry blended with 2,496 lb (about 1339 kg) of Montel [Profax] PROFAX[®] PF-015 polypropylene (PP). The dry mixture was melt blended using a single screw compounding extruder to give a mixture containing 20 weight-percent of barium titanate.

The paragraph on page 36, beginning with the words "A 600-lb. (273-kg) portion ..." has been amended as follows:

A 600-lb. (273-kg) portion of the 20 weight-percent concentrate prepared above was then blended with 1800 lb (about 818 kg) of Montel [Profax] PROFAX[®] PF-015 polypropylene. This dry blend was melt blended using a single screw compounding extruder to yield a 5 weight-percent barium titanate/polypropylene composite.

The paragraph on page 378, beginning with the words "Samples of meltblown material ..." has been amended as follows:

Samples of meltblown material were taken from ten cross deckle positions (i.e. 2 per 20-inch slit) of the nonwoven webs described above. Samples were cut as flat sheets approximately 8-inches (about 20-cm) square. A minimum of 20 samples were evaluated for pressure drop (Δp in mm H₂O) and percent particle penetration (% P). Tables 13 through 15 summarize the pressure drop and particle penetration data for the control (Montel [Profax] PROFAX[®] PF-015) and the barium titanate containing formulations.